OIPE
NOV 27 2000
PATENT & TRADEMARK OFFICE 2820

#4
DRUM
10-24-01

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application. No:	09/638,271
Filed:	August 14, 2000
Inventor(s):	Dinesh Nair, Siming Lin, Darren Schmidt, and Nicolas Vazquez
Title:	System and Method for Locating Color and Pattern Match Regions in a Target Image
Examiner:	Unknown
Group/Art Unit:	2622

§

Atty. Dkt. No: 5150-43600

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to Assistant Commissioner for Patents, Washington, DC 20231, on the date indicated below.

Jeffrey C. Hood

11/22/2000
Date

Signature

SUBMISSION OF FORMAL DRAWINGS

RECEIVED
DEC
Technology Center 2600

Official Draftsman
Assistant Commissioner for Patents
Washington, D.C. 20231

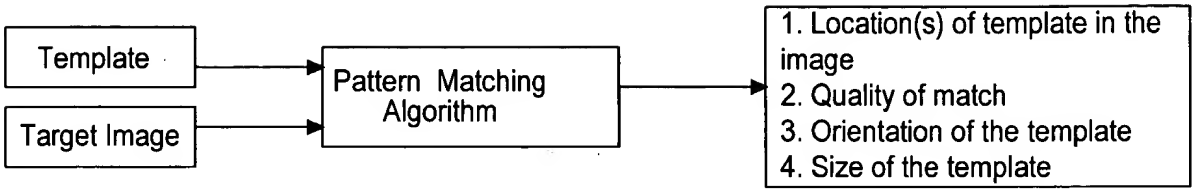
Sir:

Applicant hereby submits the formal drawings for the above-referenced application and requests that these drawings (Figures 1-27 on 26 sheets) be accepted for filing.

Respectfully submitted,

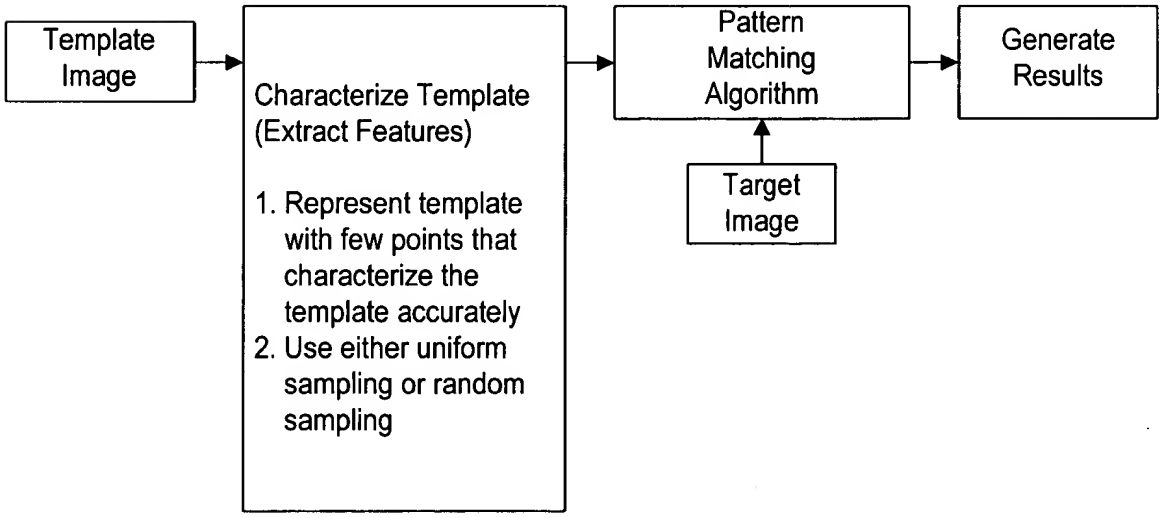
Jeffrey C. Hood
Reg. No. 35,198
ATTORNEY FOR APPLICANTS

Conley, Rose & Tayon, P.C.
P.O. Box 398
Austin, TX 78767-0398
(512) 476-1400



PRIOR ART PATTERN MATCHING

FIG. 1



PRIOR ART PATTERN MATCHING WITH CHARACTERIZATION OF THE TEMPLATE IMAGE

FIG. 2

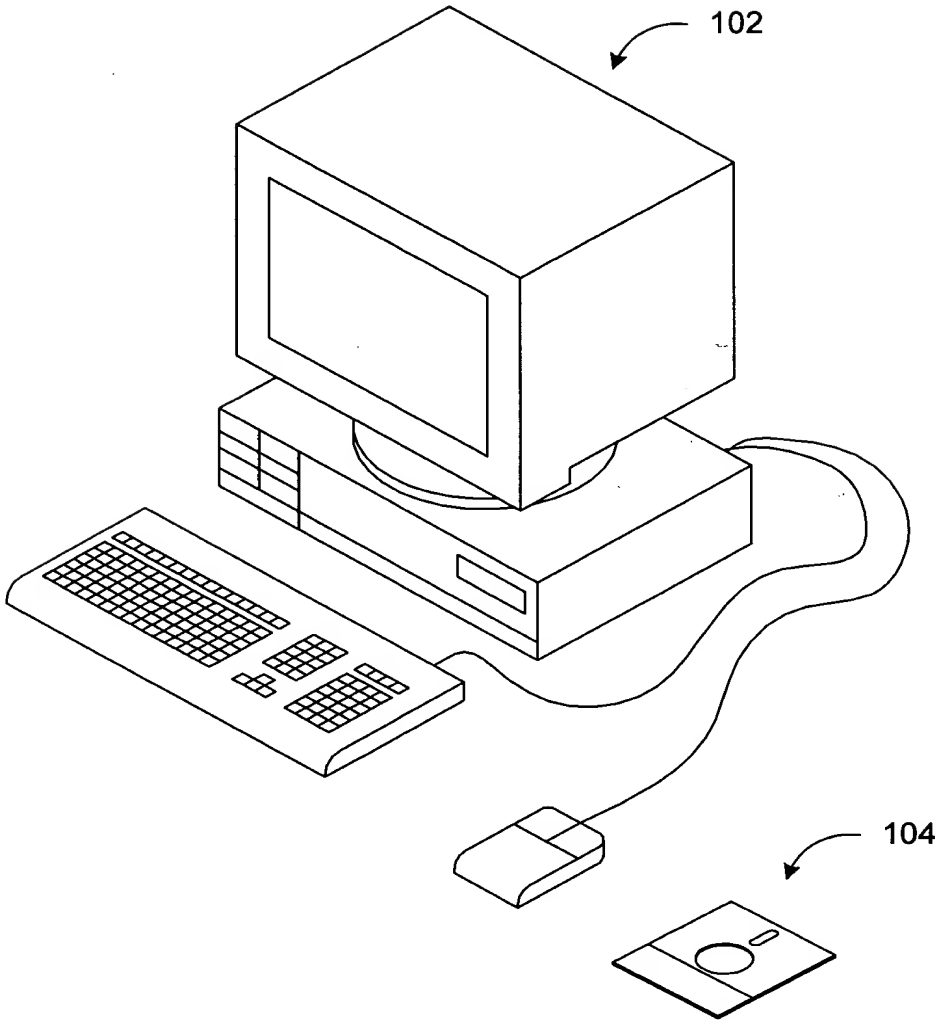


FIG. 3

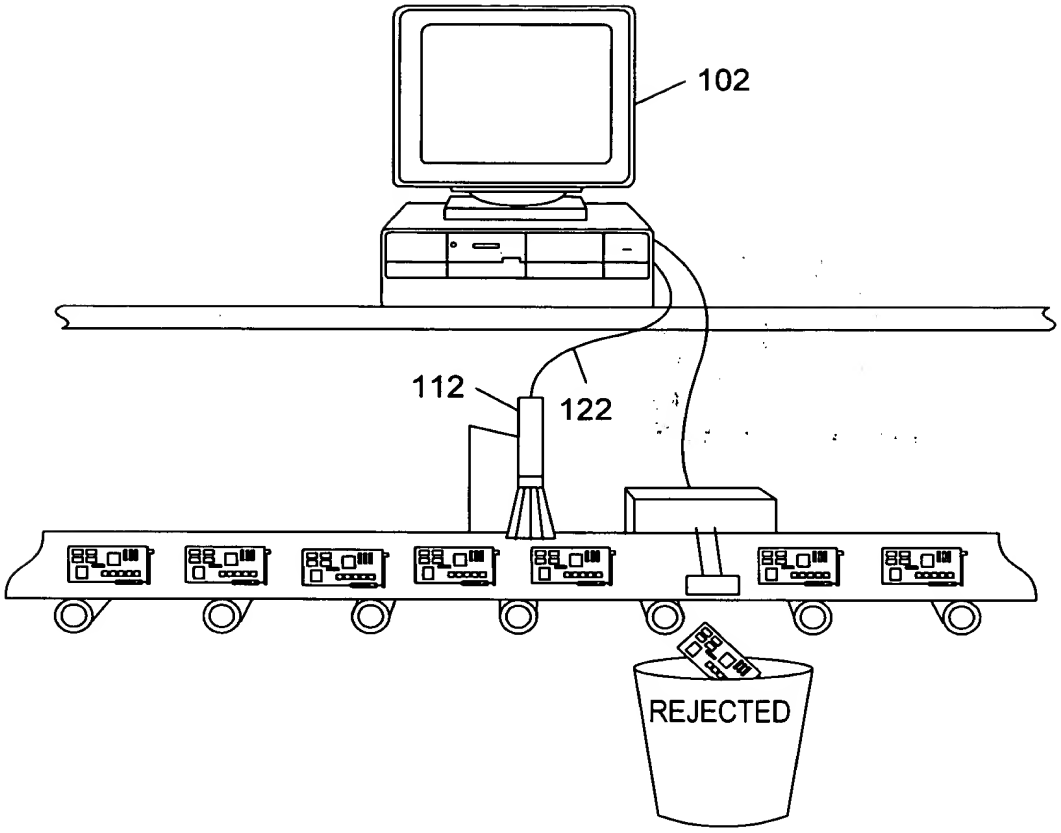


FIG. 4

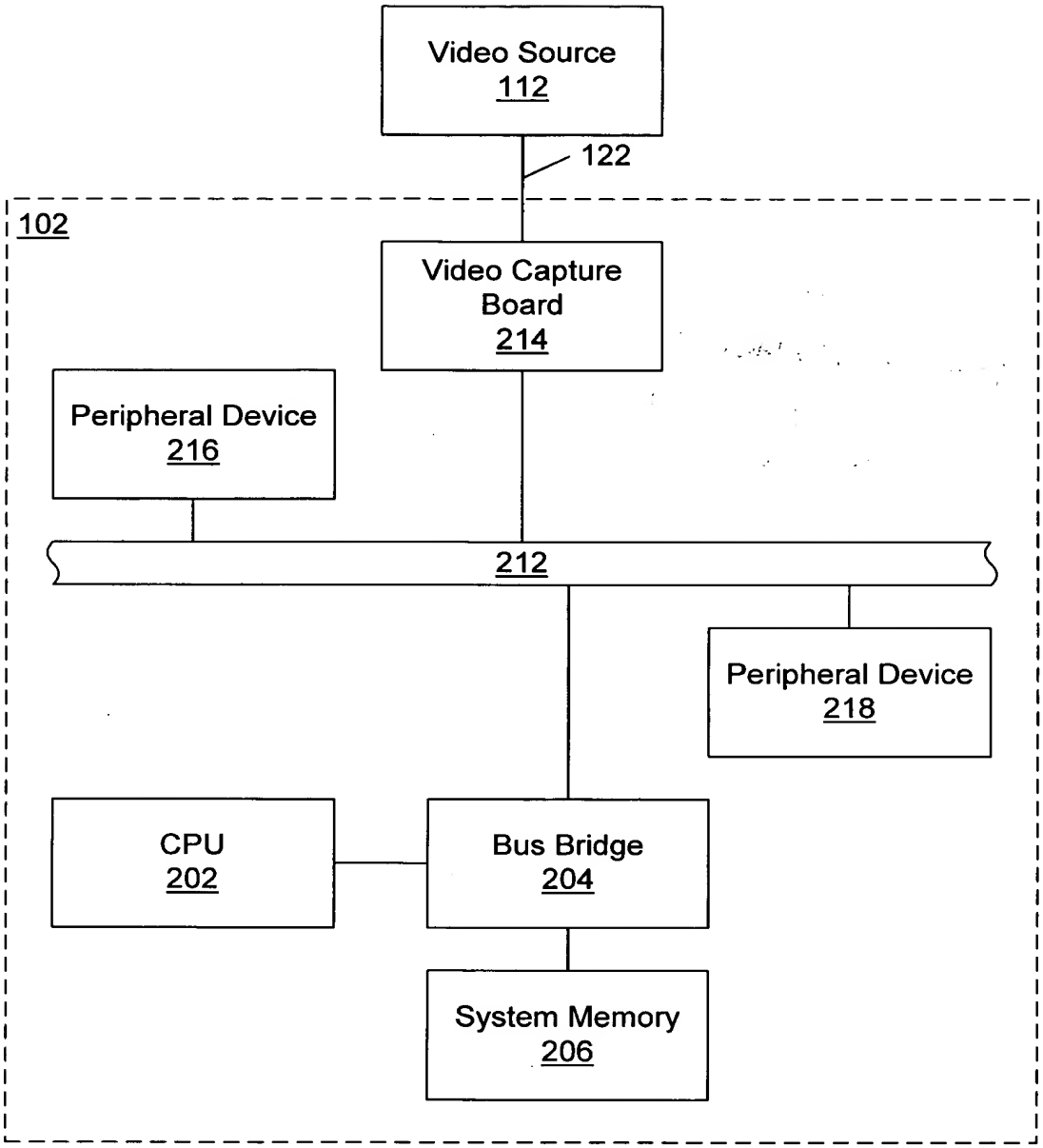

Video Source
112
122
102
Video Capture
Board
214
Peripheral Device
216
212
Peripheral Device
218
CPU
202
Bus Bridge
204
System Memory
206

FIG. 5

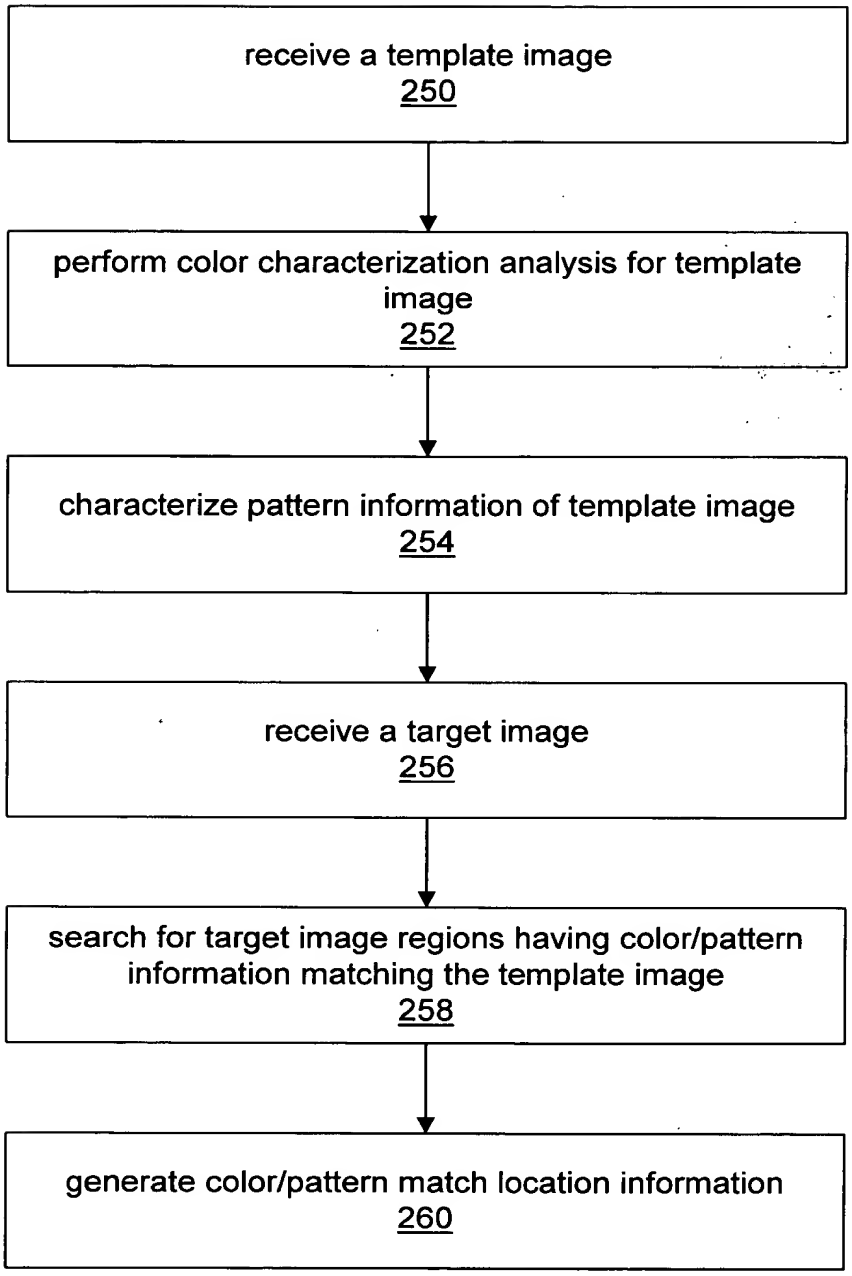

receive a template image
250
perform color characterization analysis for template image
252
characterize pattern information of template image
254
receive a target image
256
search for target image regions having color/pattern information matching the template image
258
generate color/pattern match location information
260

FIG. 6

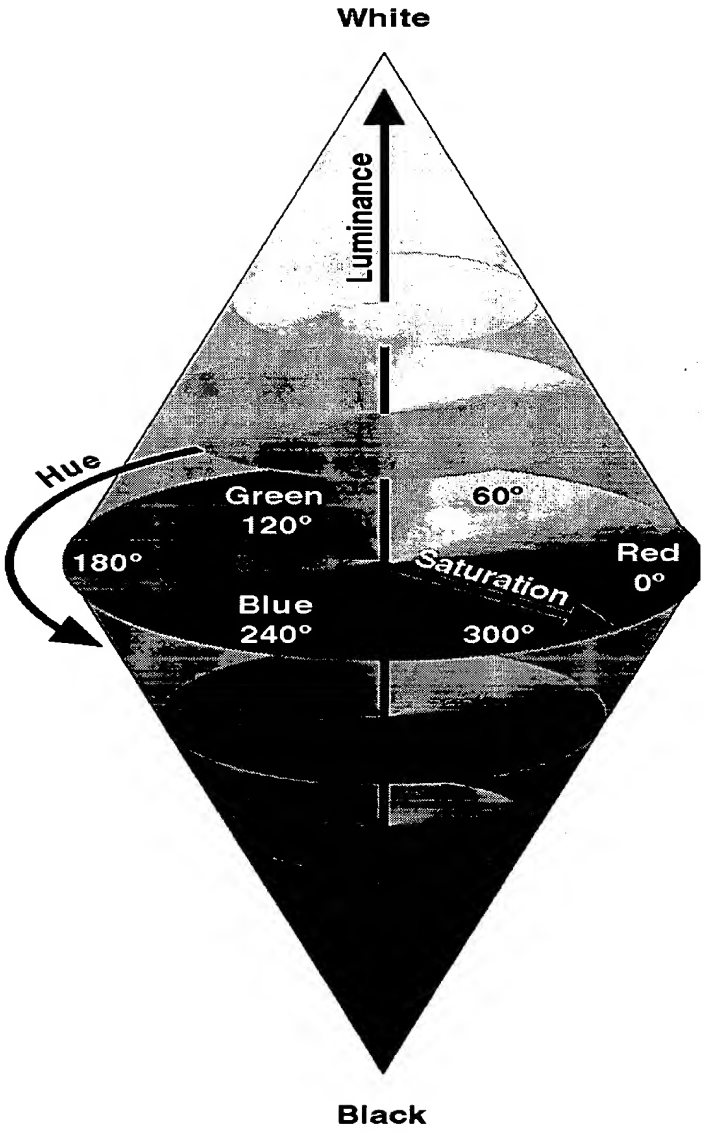

White
Luminance
Hue
Green
120°
60°
180°
Red
0°
Saturation
Blue
240°
300°
Black

FIG. 7

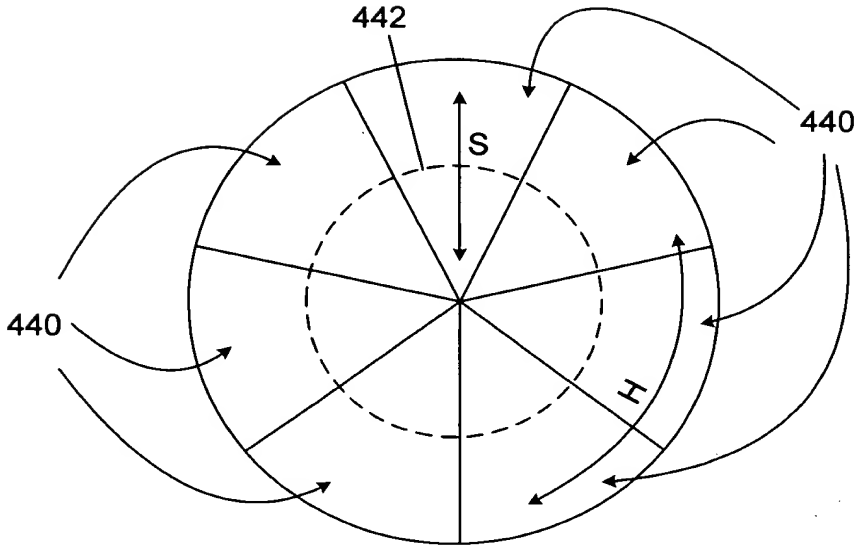


FIG. 8A

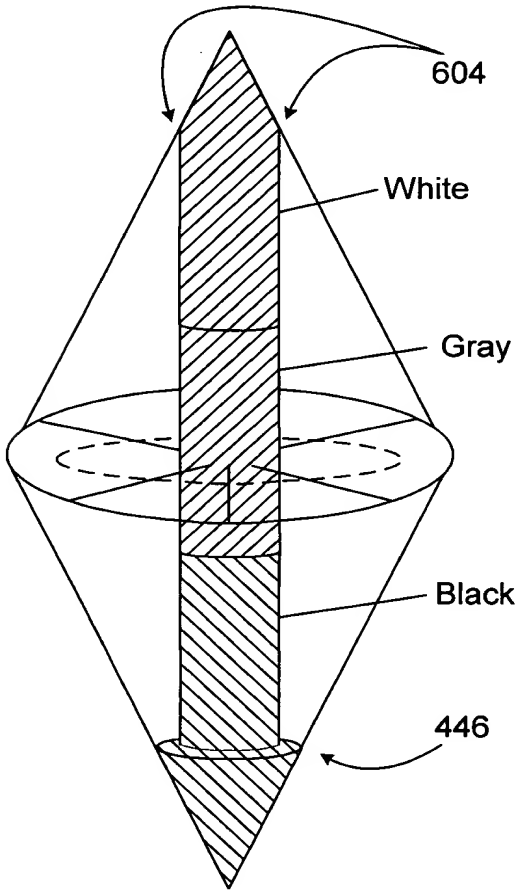


FIG. 8B

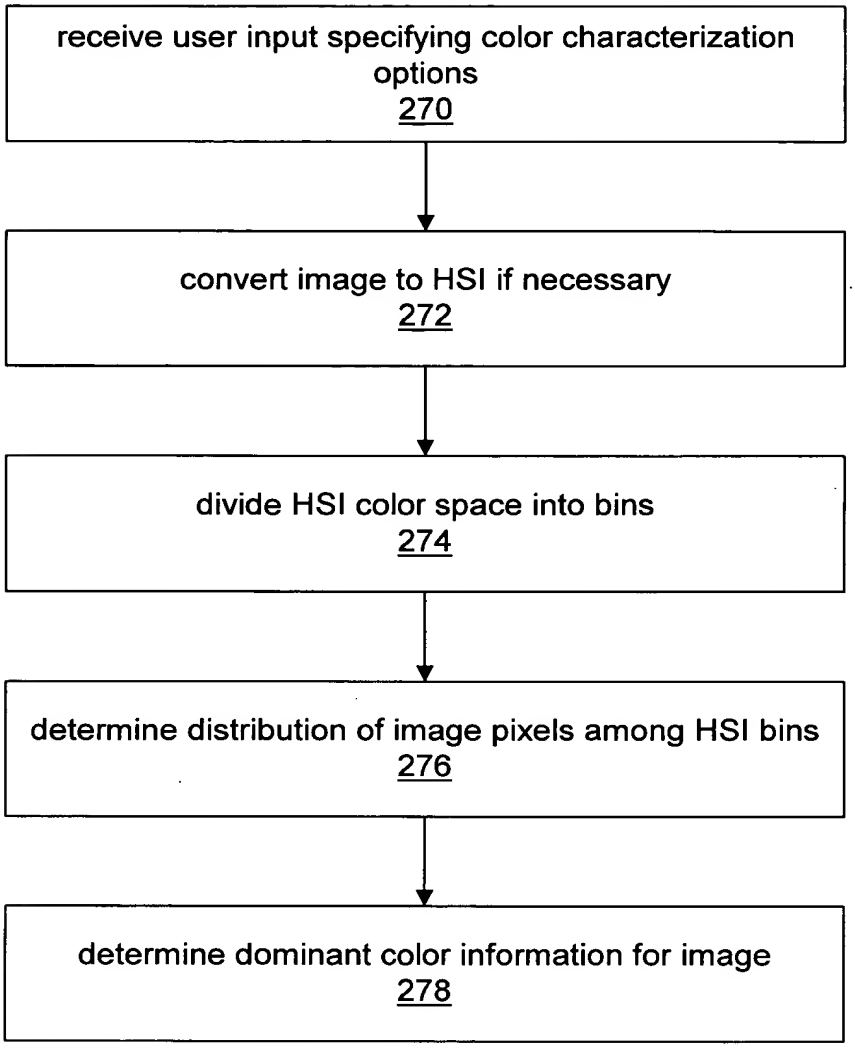

receive user input specifying color characterization options
270
convert image to HSI if necessary
272
divide HSI color space into bins
274
determine distribution of image pixels among HSI bins
276
determine dominant color information for image
278

FIG. 9

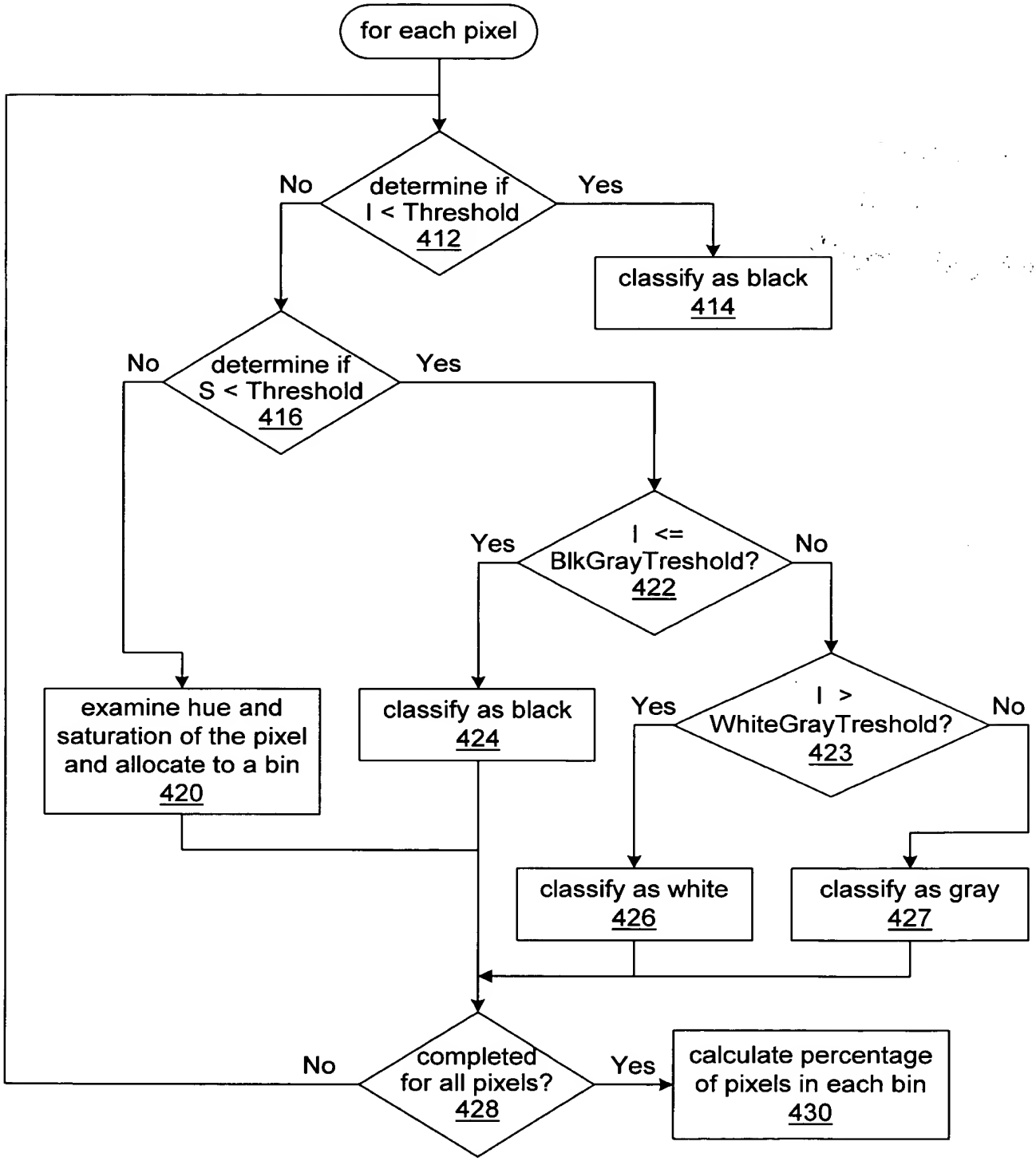

for each pixel
determine if I < Threshold 412
No
Yes
classify as black 414
determine if S < Threshold 416
No
Yes
I <= BlkGrayTreshold? 422
Yes
No
examine hue and saturation of the pixel and allocate to a bin 420
classify as black 424
I > WhiteGrayTreshold? 423
Yes
No
classify as white 426
classify as gray 427
completed for all pixels? 428
No
Yes
calculate percentage of pixels in each bin 430

FIG. 10

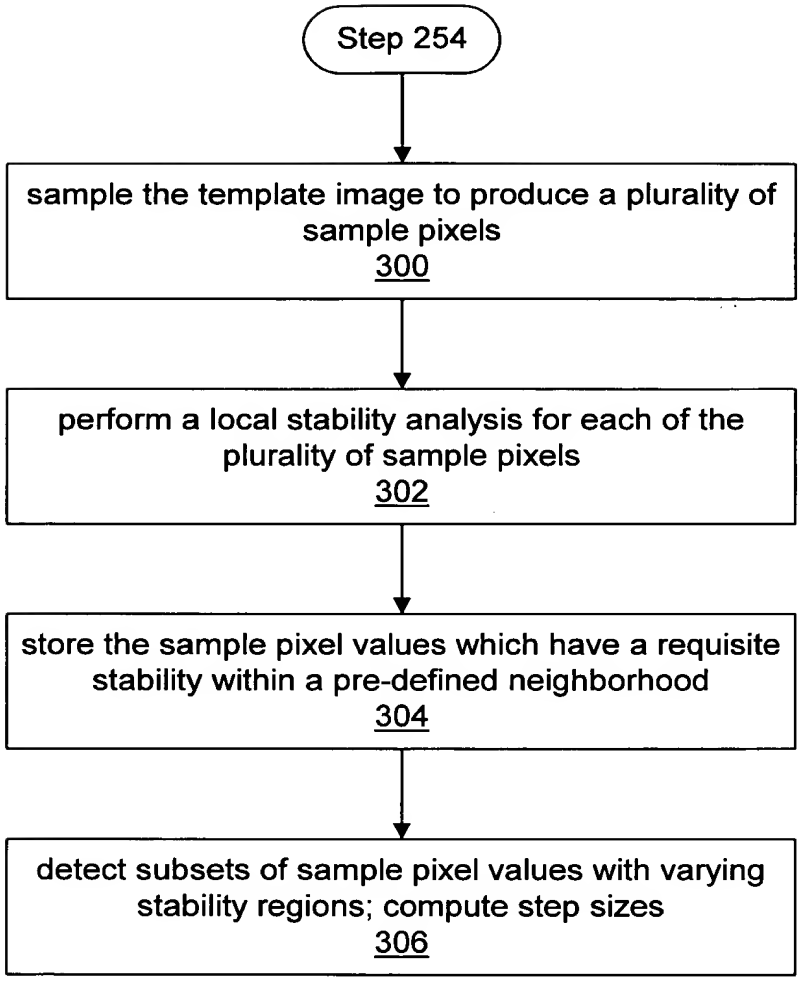

Step 254
sample the template image to produce a plurality of sample pixels
300
perform a local stability analysis for each of the plurality of sample pixels
302
store the sample pixel values which have a requisite stability within a pre-defined neighborhood
304
detect subsets of sample pixel values with varying stability regions; compute step sizes
306

FIG. 11

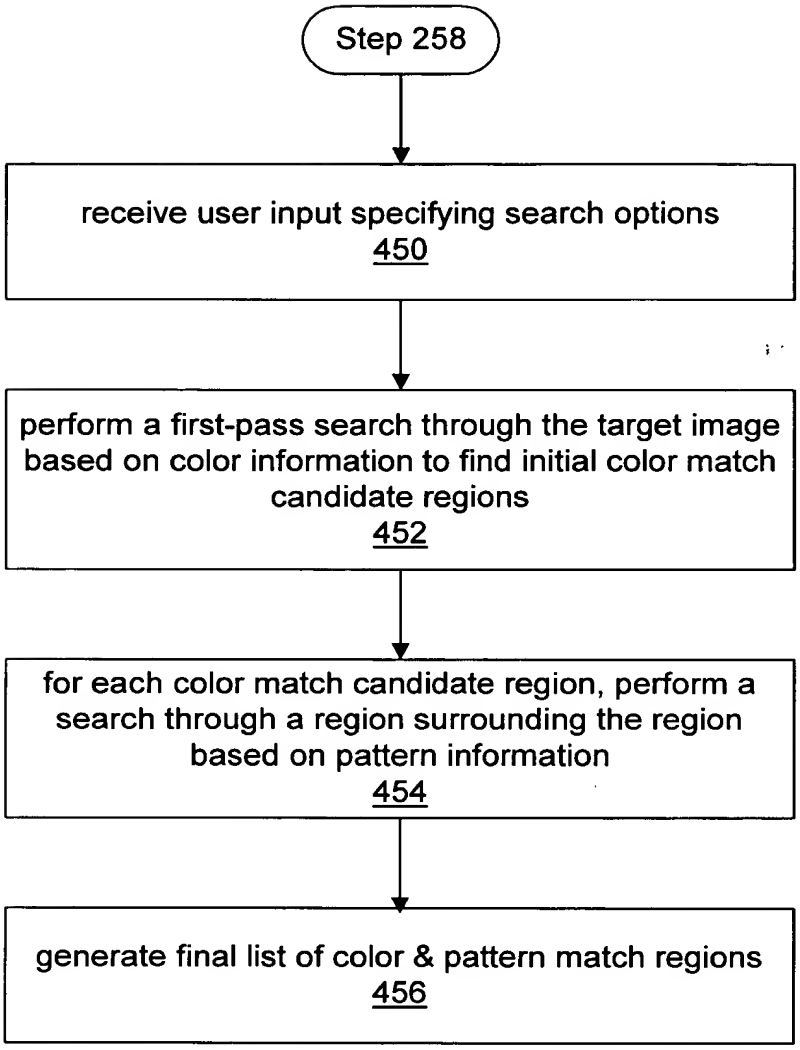

Step 258
receive user input specifying search options
450
perform a first-pass search through the target image based on color information to find initial color match candidate regions
452
for each color match candidate region, perform a search through a region surrounding the region based on pattern information
454
generate final list of color & pattern match regions
456

FIG. 12

9 x 9 Pixel Step Size

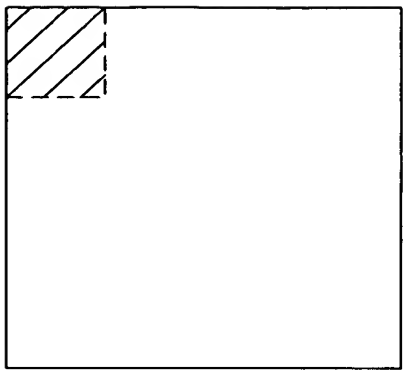


FIG. 13a

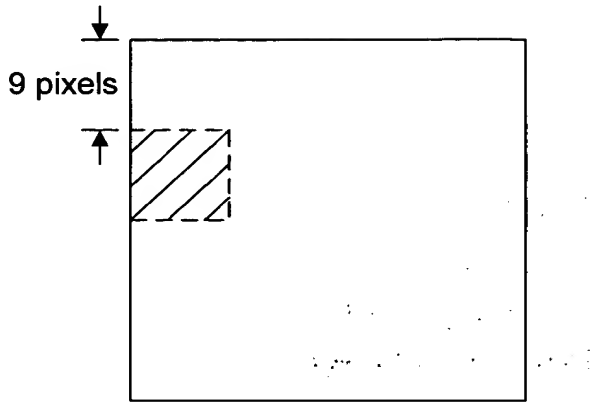


FIG. 13b

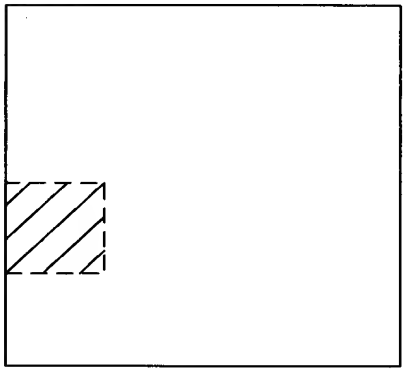


FIG. 13c

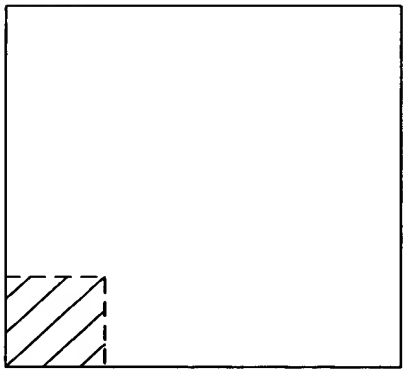


FIG. 13d

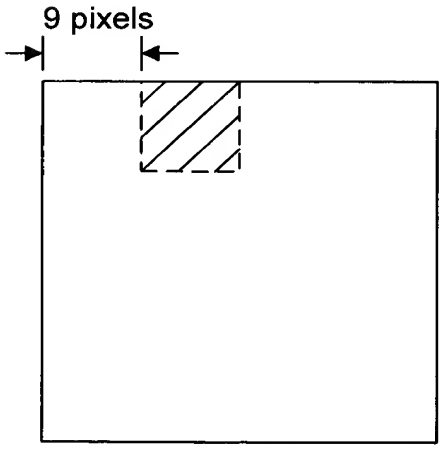


FIG. 13e

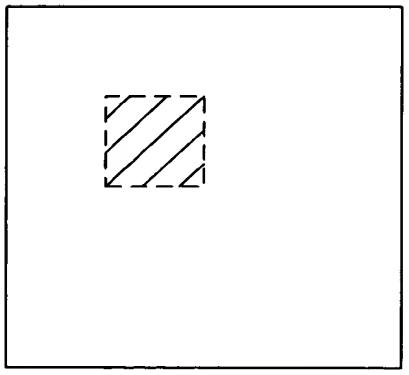


FIG.13f

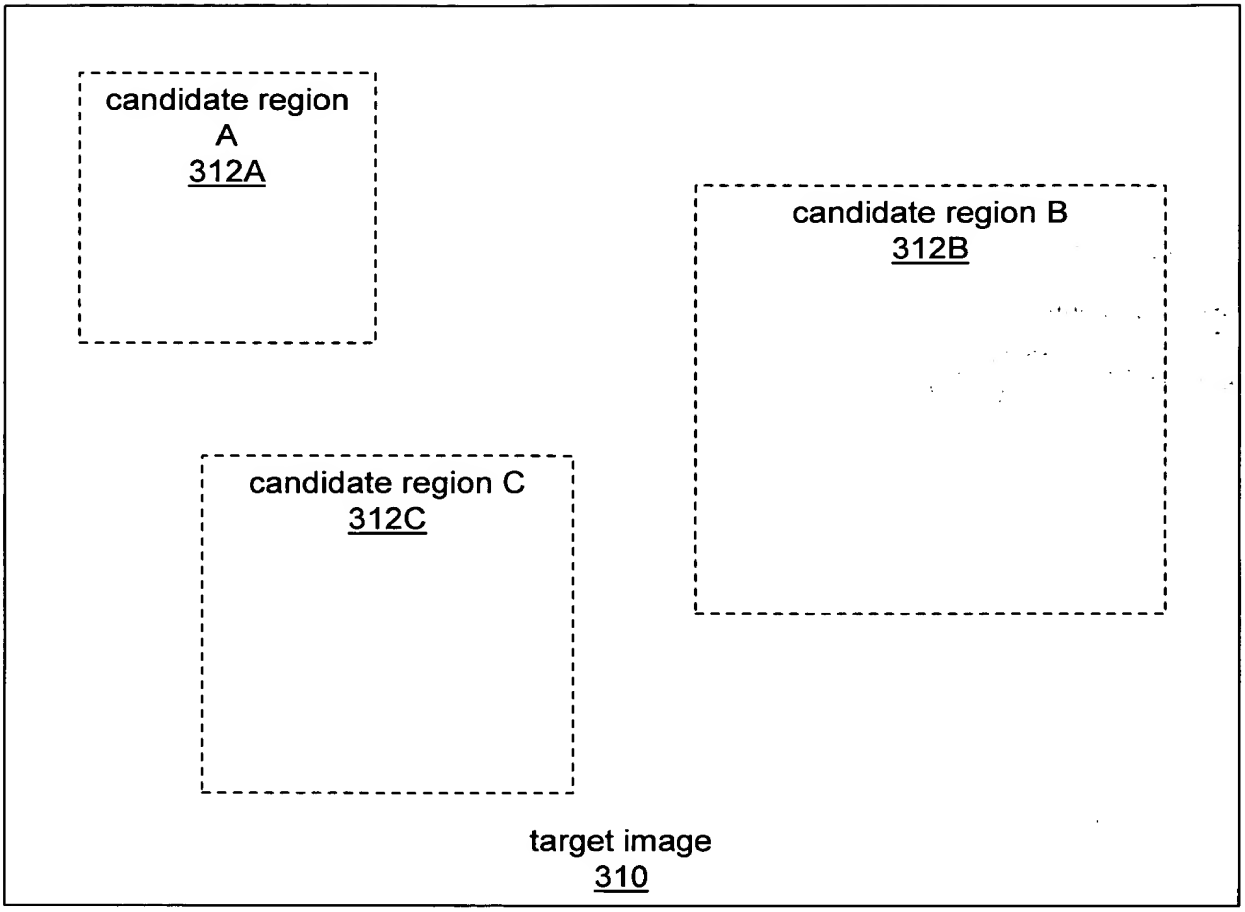

candidate region
A
312A
candidate region B
312B
candidate region C
312C
target image
310

FIG. 14

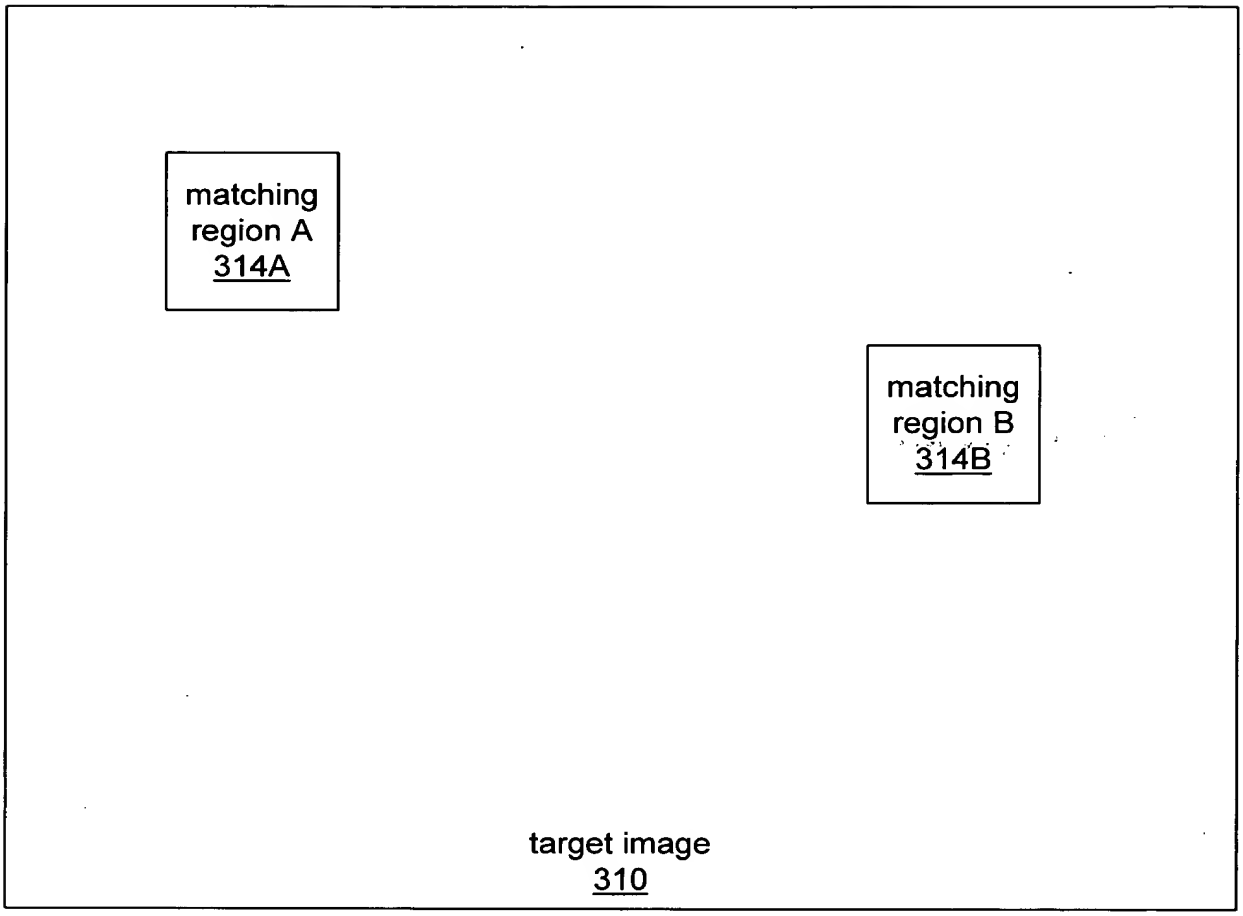

matching region A 314A
matching region B 314B
target image 310

FIG. 15

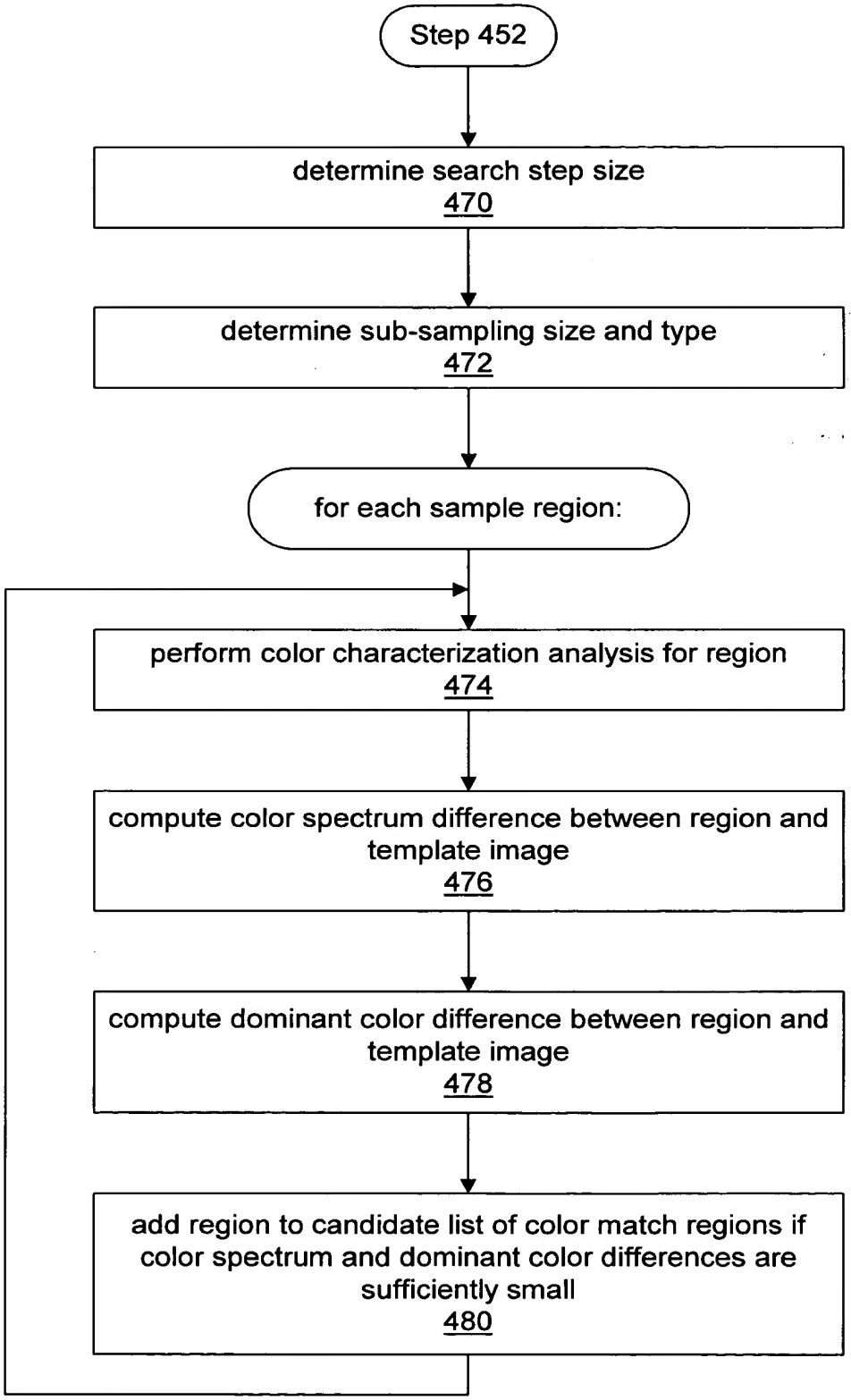

Step 452
determine search step size
470
determine sub-sampling size and type
472
for each sample region:
perform color characterization analysis for region
474
compute color spectrum difference between region and template image
476
compute dominant color difference between region and template image
478
add region to candidate list of color match regions if color spectrum and dominant color differences are sufficiently small
480

FIG. 16

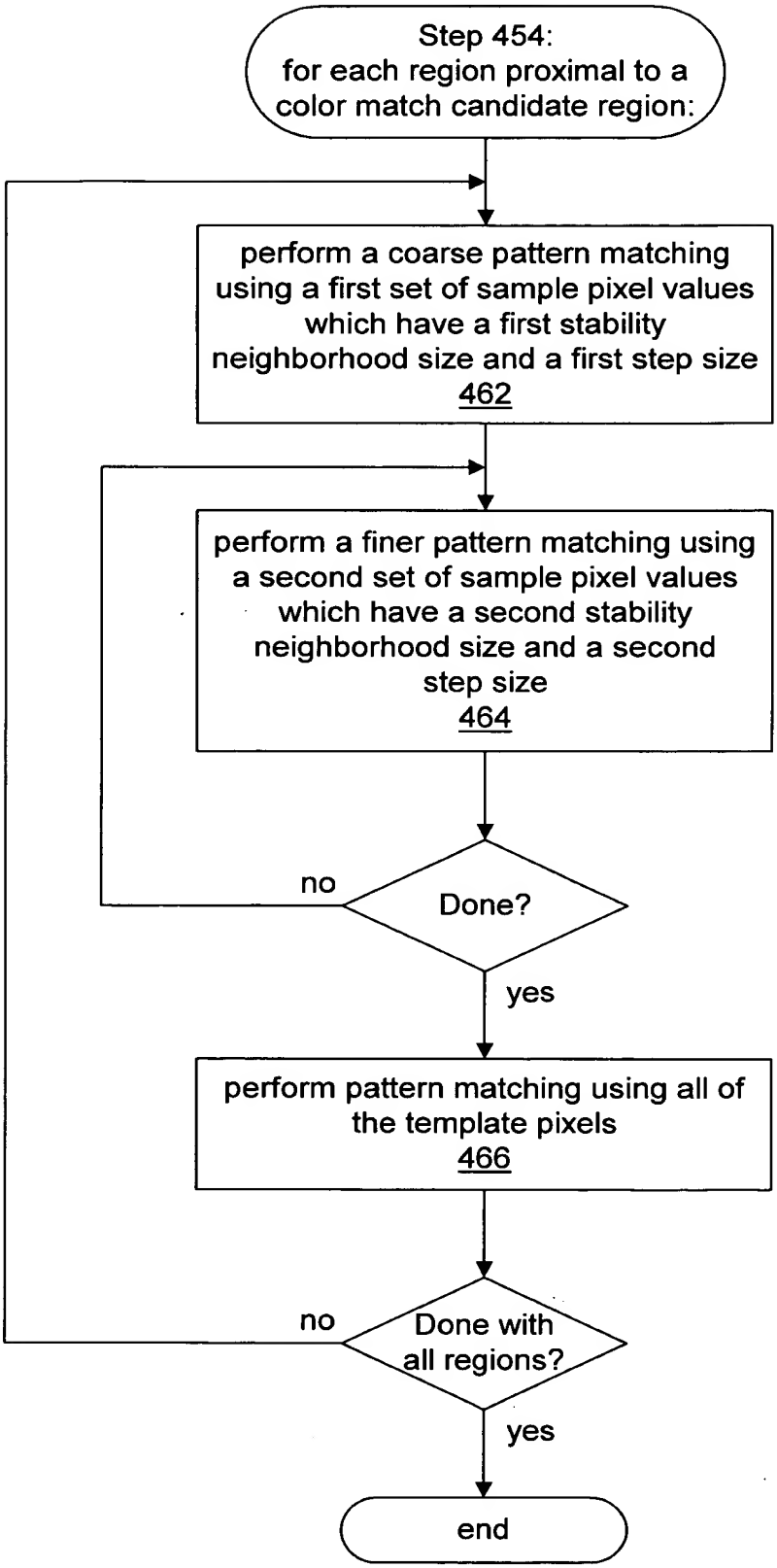

Step 454:
for each region proximal to a color match candidate region:
perform a coarse pattern matching using a first set of sample pixel values which have a first stability neighborhood size and a first step size
462
perform a finer pattern matching using a second set of sample pixel values which have a second stability neighborhood size and a second step size
464
Done?
no
yes
perform pattern matching using all of the template pixels
466
Done with all regions?
no
yes
end

FIG. 17

5 x 5 Pixel Step Size

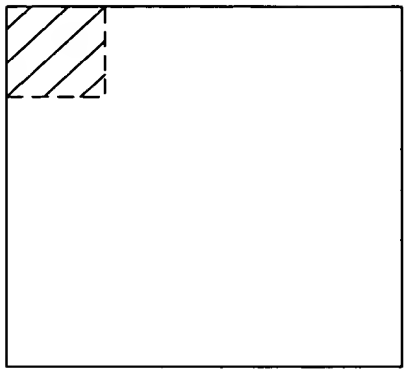


FIG. 18a

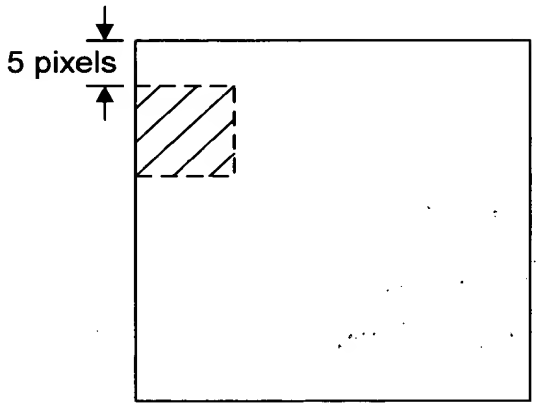


FIG. 18b

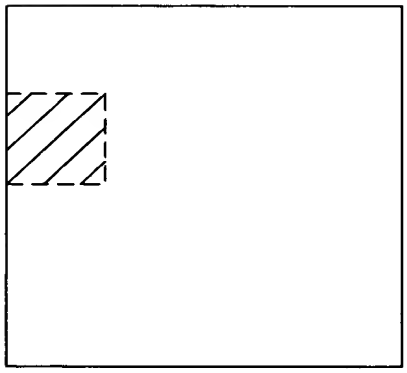


FIG. 18c

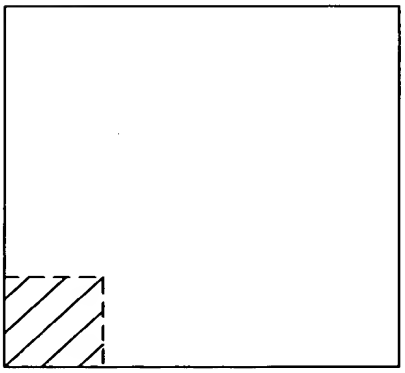


FIG. 18d

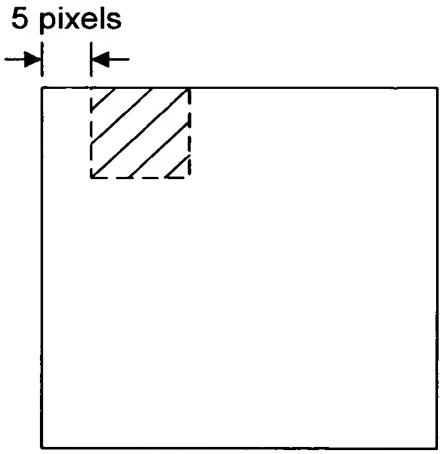


FIG. 18e

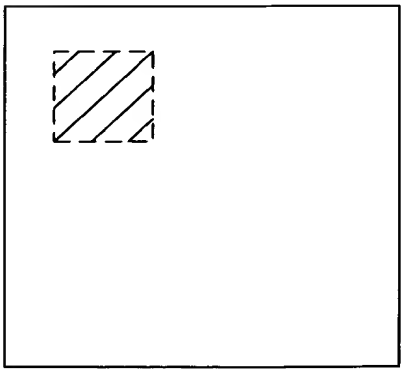


FIG. 18f

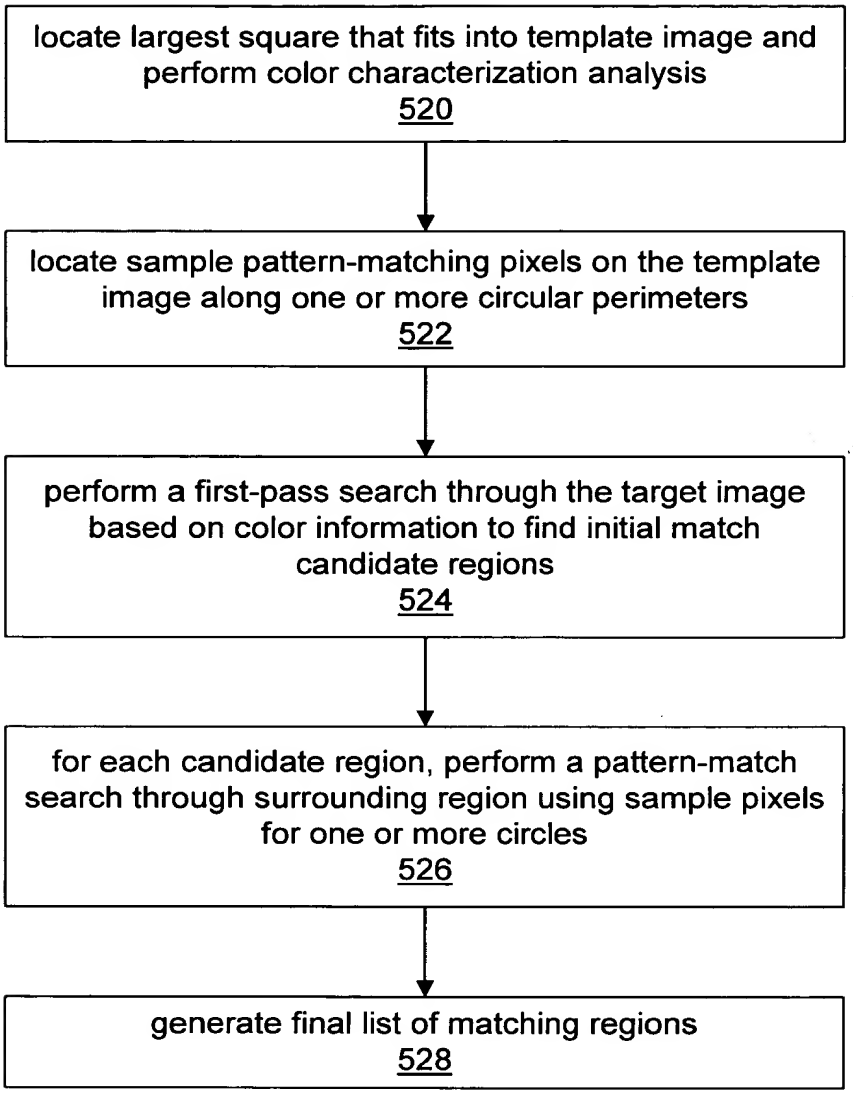

locate largest square that fits into template image and perform color characterization analysis
520
locate sample pattern-matching pixels on the template image along one or more circular perimeters
522
perform a first-pass search through the target image based on color information to find initial match candidate regions
524
for each candidate region, perform a pattern-match search through surrounding region using sample pixels for one or more circles
526
generate final list of matching regions
528

FIG. 19

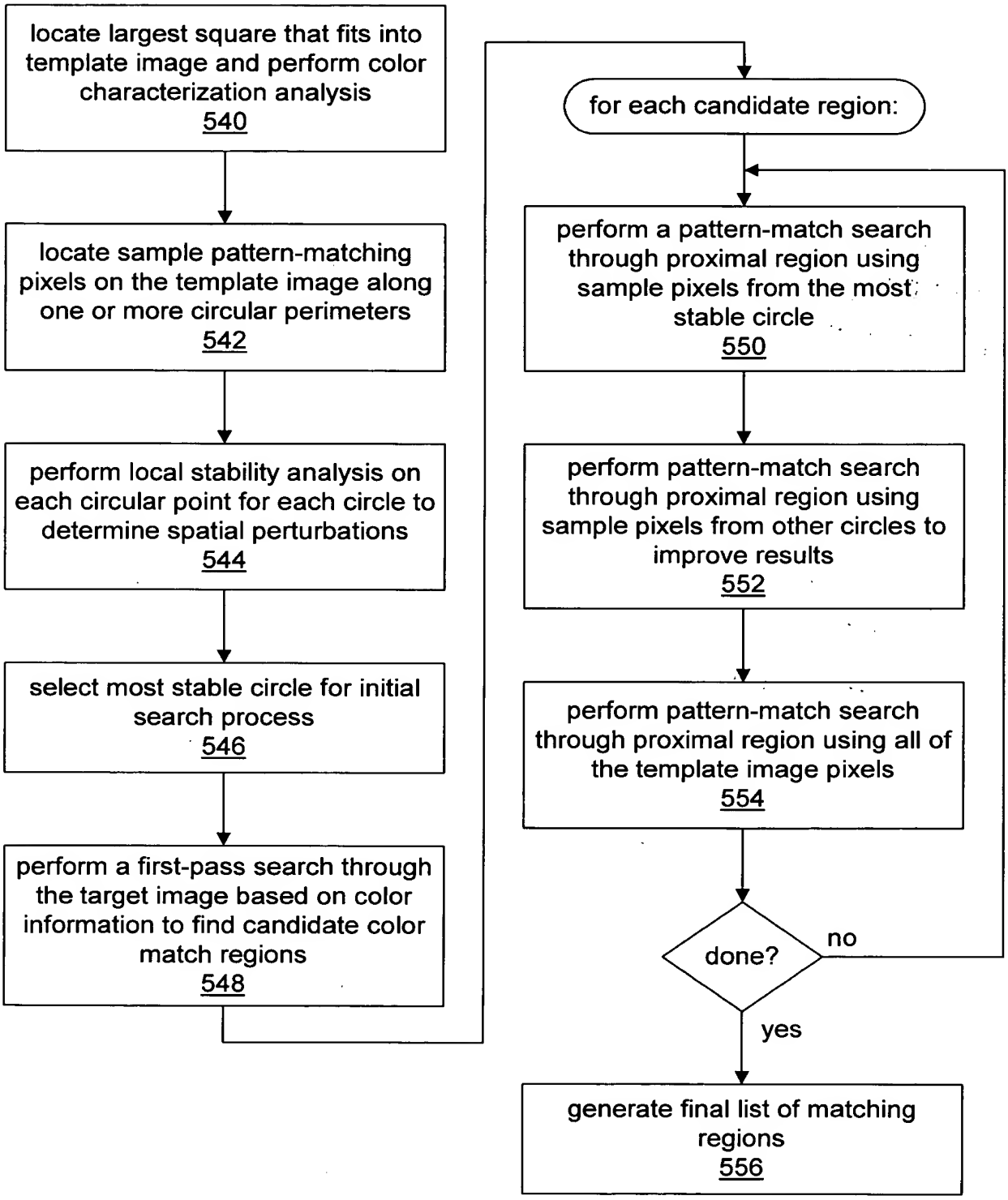

locate largest square that fits into template image and perform color characterization analysis
540
locate sample pattern-matching pixels on the template image along one or more circular perimeters
542
perform local stability analysis on each circular point for each circle to determine spatial perturbations
544
select most stable circle for initial search process
546
perform a first-pass search through the target image based on color information to find candidate color match regions
548
for each candidate region:
perform a pattern-match search through proximal region using sample pixels from the most stable circle
550
perform pattern-match search through proximal region using sample pixels from other circles to improve results
552
perform pattern-match search through proximal region using all of the template image pixels
554
done?
no
yes
generate final list of matching regions
556

FIG. 20

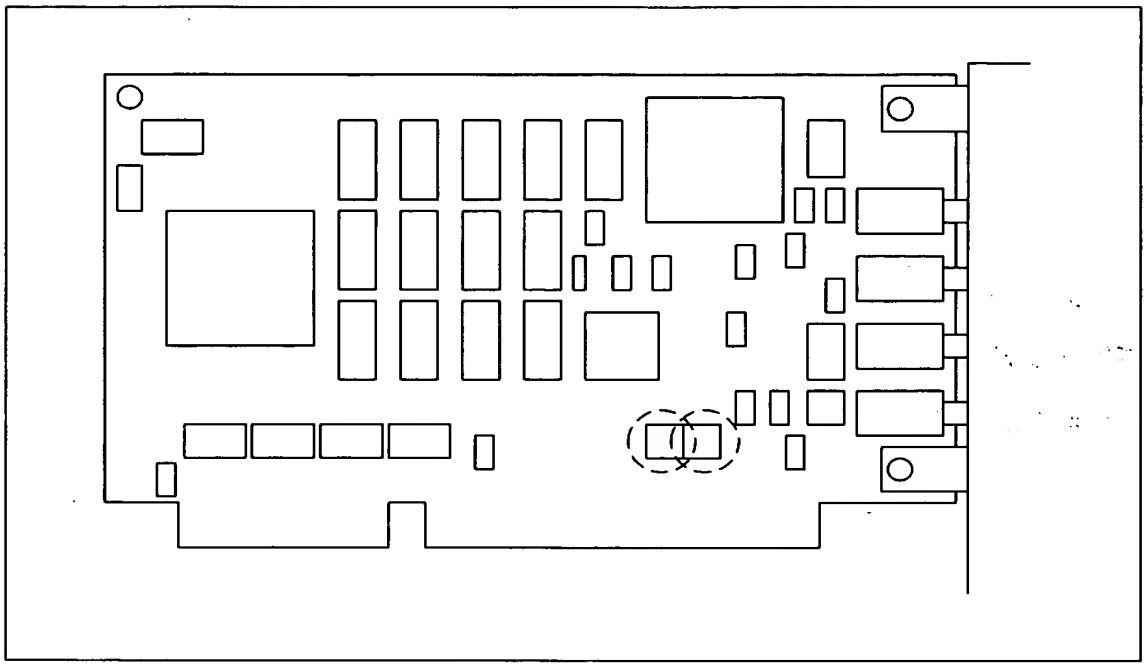


FIG. 21A

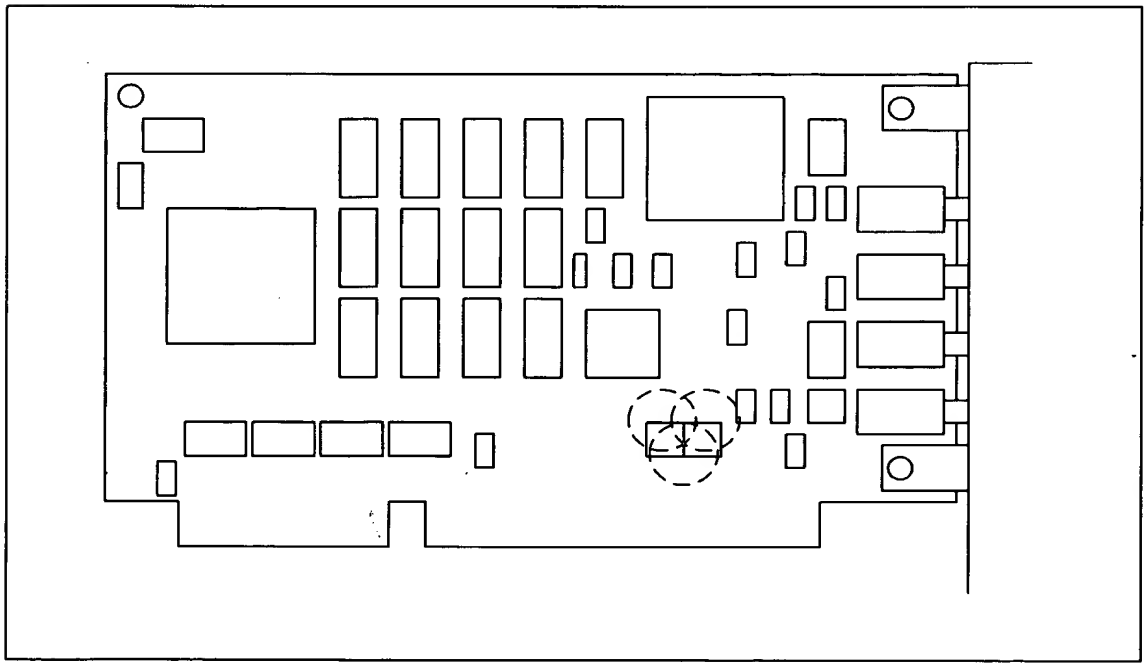


FIG. 21B

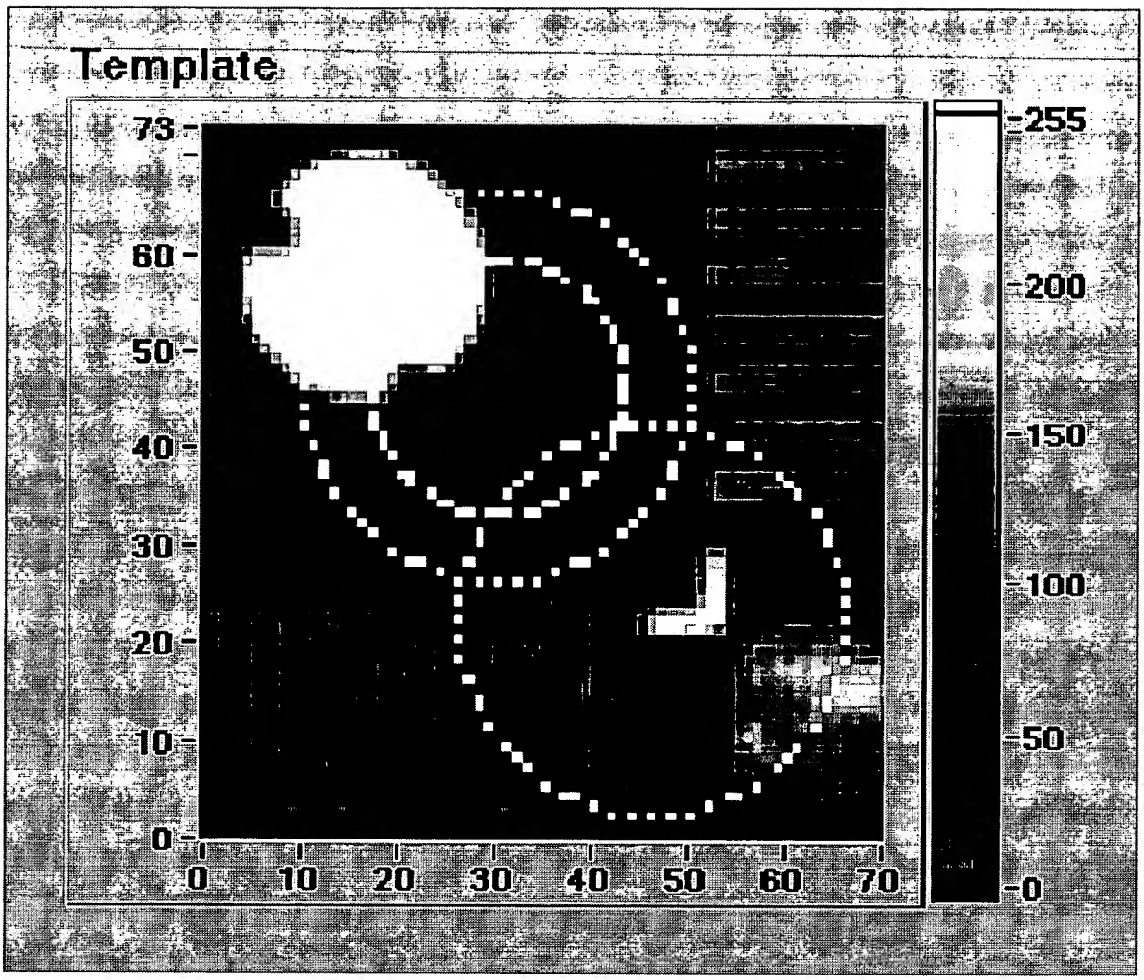

Template
73
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
255
200
150
100
50
0

FIG. 22

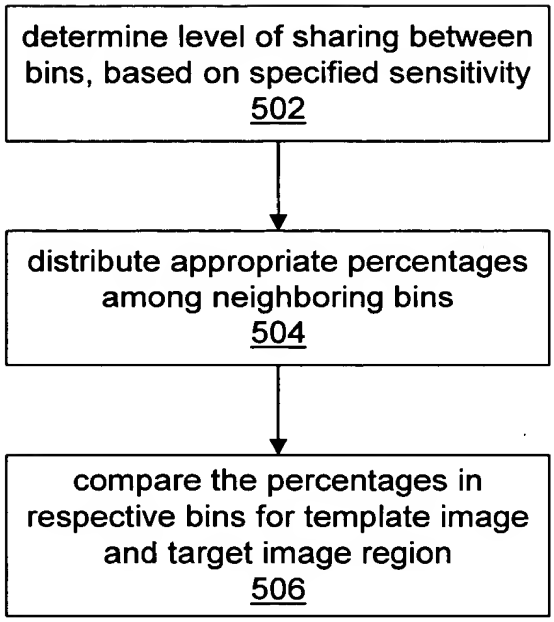

determine level of sharing between bins, based on specified sensitivity
502
distribute appropriate percentages among neighboring bins
504
compare the percentages in respective bins for template image and target image region
506

FIG. 23

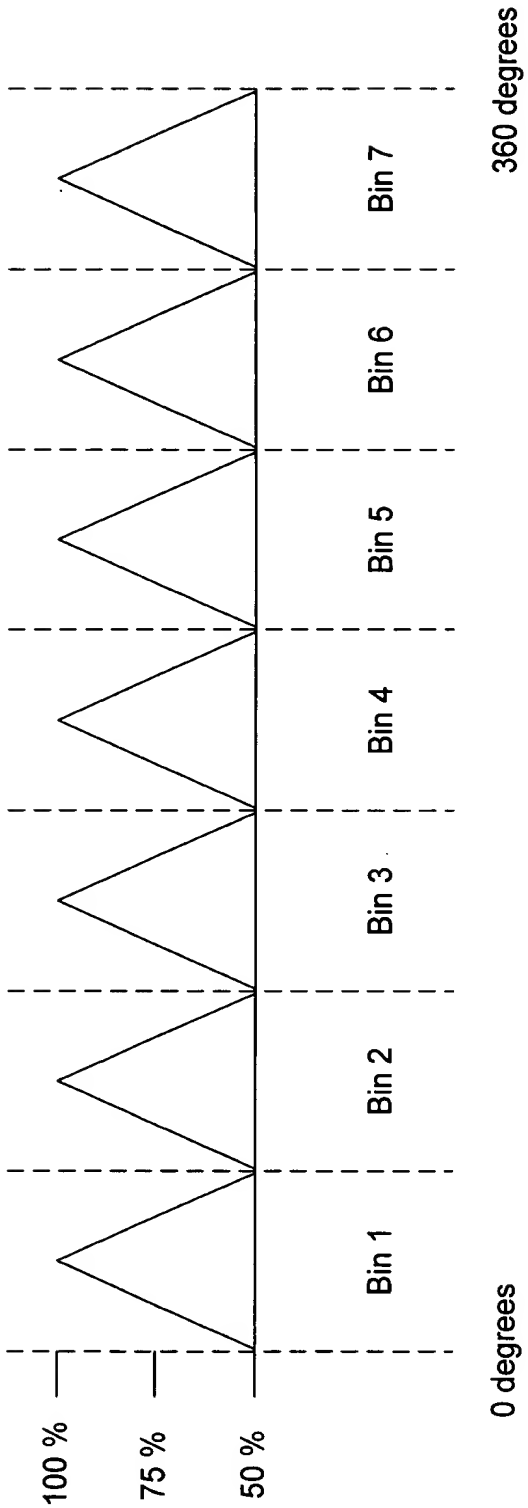

100 %
75 %
50 %
0 degrees
360 degrees
Bin 1
Bin 2
Bin 3
Bin 4
Bin 5
Bin 6
Bin 7

FIG. 24

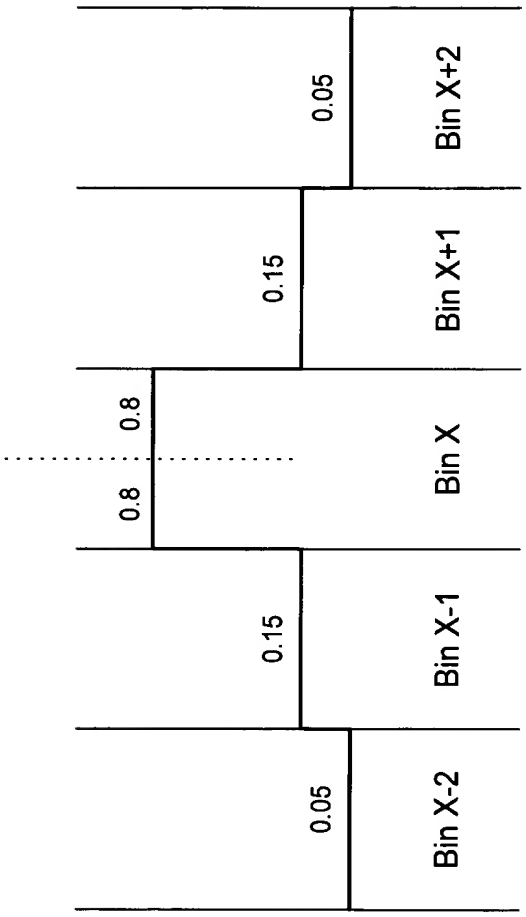


FIG. 25

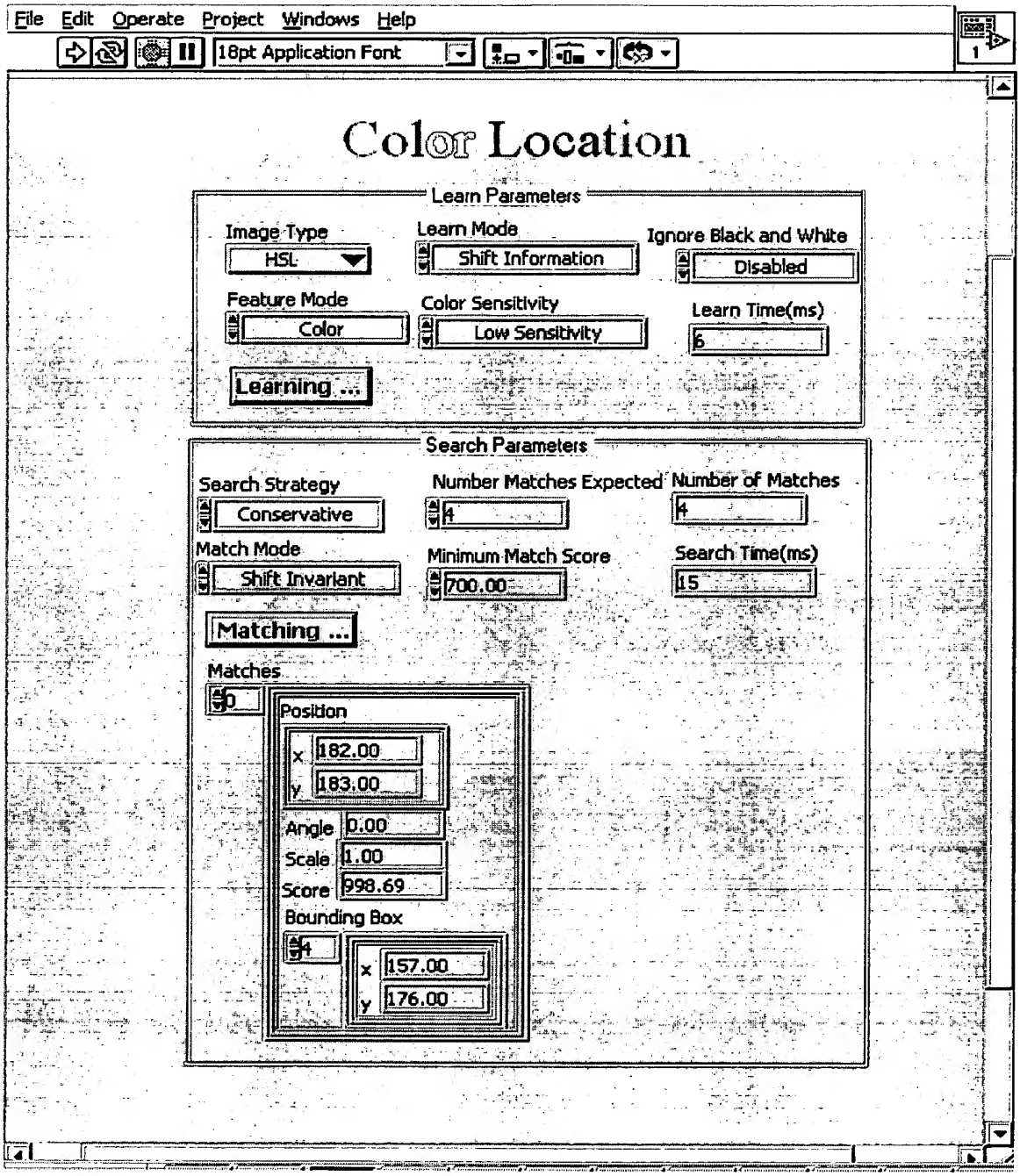

File Edit Operate Project Windows Help
18pt Application Font
Color Location
Learn Parameters
Image Type
HSL
Learn Mode
Shift Information
Ignore Black and White
Disabled
Feature Mode
Color
Color Sensitivity
Low Sensitivity
Learn Time(ms)
6
Learning ...
Search Parameters
Search Strategy
Conservative
Number Matches Expected
4
Number of Matches
4
Match Mode
Shift Invariant
Minimum Match Score
700.00
Search Time(ms)
15
Matching ...
Matches
0
Position
x 182.00
y 183.00
Angle 0.00
Scale 1.00
Score 998.69
Bounding Box
4
x 157.00
y 176.00

FIG. 26

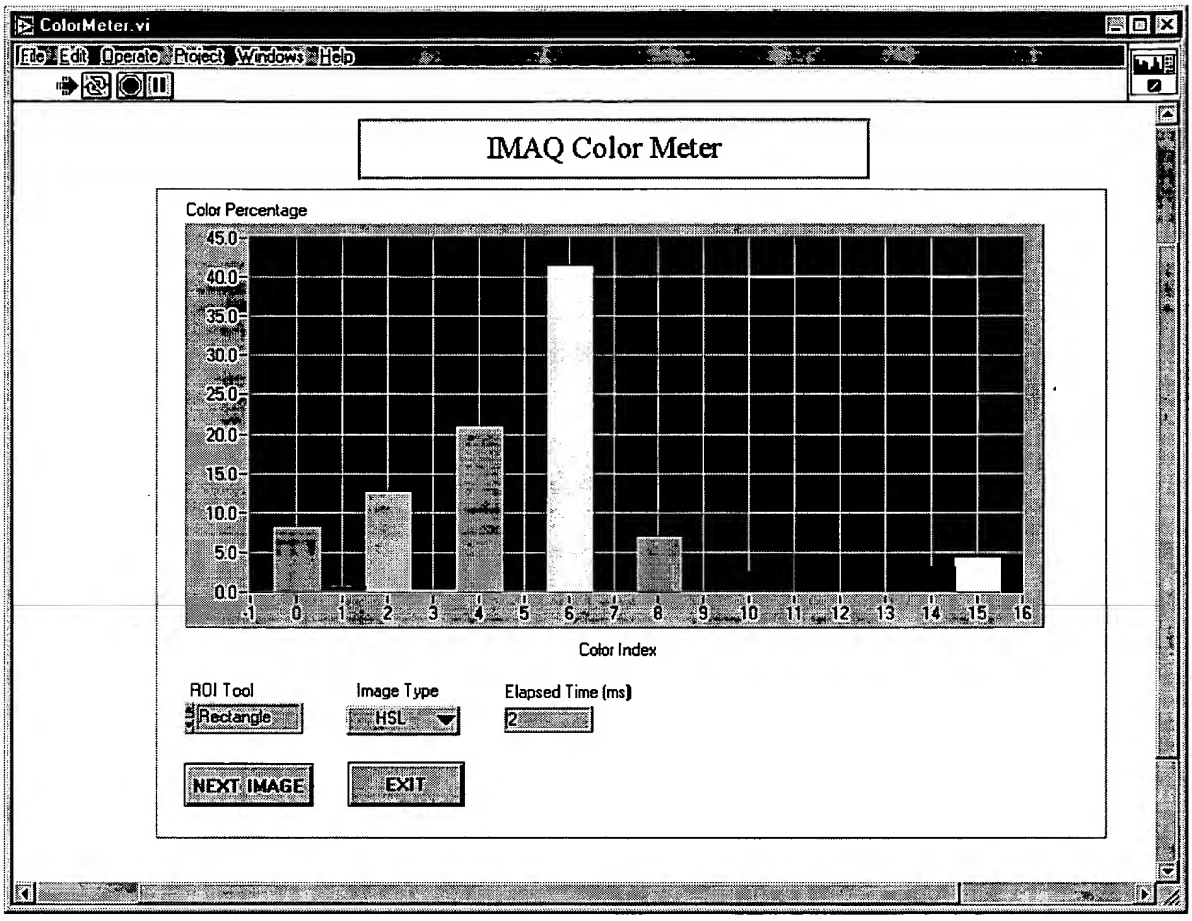

ColorMeter.vi
File Edit Operate Project Windows Help
IMAQ Color Meter
Color Percentage
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Color Index
ROI Tool
Rectangle
Image Type
HSL
Elapsed Time (ms)
2
NEXT IMAGE
EXIT

FIG. 27